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COST OF TRANSPORTATION ON RAILROADS.

By CHARLES ELLET, *Civil Engineer.*

On the value of Gradients.—In the preceding number I proposed a formula for the determination of the cost of transportation on railroads. I am aware that that expression is not in accordance with the opinion which now prevails in regard to the economy of railroad conveyance; and that there are many gentlemen of experience and reputation who are prepared to adopt a much lower estimate than mine. But, until some road can be adduced on which the experiment has been tried long enough to exhibit a result which can be received as a fair average, and which authorizes ower constants, I cannot consent to the reduction of the formula. In its present state it gives a result below the actual performance on any road in the United States.

I am aware that in not presenting the actual cost of freight in any particular number of cents per mile, or in any particular sum per mile travelled by the locomotive engines, I have deviated from the popular and most approved methods of treating the subject. But I regard the aggregate cost per mile run as no guide whatever to the economy which characterizes the management of a railroad; and deem it an unauthorized assumption that because this sum is, in any instance, unusually low, the work is conducted with more than ordinary success. The fact, where it exists, can only be used to prove, if other circumstances remain the same, that the engine

have taken smaller loads, and made a greater number of trips, and run more miles, than was absolutely necessary. In fact, if we admit—what cannot well be denied—that under similar circumstances, and with engines of the same class, the cost of locomotive power is proportional to the distance run—or that the cost of running one mile is not *diminished by increasing* the load, it follows as a consequence that, caeteris paribus, *The more economical the administration of a road the greater will be the aggregate cost per mile run by the locomotive engines.*

Neither is the circumstance that the aggregate expenses of a line for one yeai dividend by the number of tons conveyed, exhibits a low average per ton per mile, any test of good management. The fact, by itself, is more likely to prove that the tonnage was great than that the administration was judicious.

I shall now proceed to deduce from this general expression of the cost of freight, certain consequences of the utmost importance in the location and establishment of railroad lines, which I believe have hitherto been little, if at all, repeated.

What is the value of gradients? I mean by this question, how much more is a railroad having grades of 30 feet to the mile worth than the same road with grades of 40 feet per mile? Or, how much would good economy authorize an engineer to expend, in the construction of his road, in order to reduce the limited gradient any given amount? I have seen various intricate and laborious solutions of questions which involve the loss of *time* and the consumption of *steam* in the ascents of gradients, but I have never yet met with any examination of this interesting and all important problem. The loss of time, in this country, is usually a matter of little consequence in the transportation of merchandise; and experience teaches that the cost of motive power is very nearly proportional to the distance travelled by the engine, and very little affected within the limits which ordinarily occur in practice by irregularities in the tractile power. It is no doubt true that if we were to make observations under extreme circumstances, as where the engines move on a perfect level, and where they frequently mount the steepest grades they can possibly ascend without loads—the cost of motive power, per mile run, would be considerably increased by the increase of the acclivity of the gradients. But we have no such extreme cases in practice; aud the following investigation is based on the perfectly authorized assumption, that the cost of running the locomotive engine, with its tender, is proportional to the

distance run, and independent of the variations of the tractile force consequent on the ordinary irregularities of grade.

In the preceding number, the aggregate annual expenses of a line of railroad, under good management, were represented by this formula;

$$\frac{3}{10}\,N + \frac{14\,T}{1000} + 500\,h, \qquad (A)$$

in which N is put for the number of miles travelled during the year, by the locomotive engine, T the number of tons, nett, carried one mile, and *h* for the length of the line of the road. This formula, it will be observed, expresses the cost of transportation without any direct computation of the effect of the grades over which the tonnage is carried. Nevertheless, the result which it yields is not independent of the grades; for they enter into the value of N, and control the number of miles travelled by the engines. The variation of the maximum gradient will not cause a sensible variation of any item of the aggregate cost of transportation excepting that of the locomotive power.

Now, in deducing the changes in the cost of locomotive power consequent on changes of grade, I shall assume that the circumstances of the trade are such as will permit that the machine be always started with a full train—that is to say, with the heaviest train which it is certain to control on the limiting grade. In many instances this assumption is not strictly in accordance with the facts; since it is frequently advisable—particularly where the grades are light and the trade inconsiderable—to effect a portion of the transportation with imperfect loads. In such cases greater ascents might obviously be encountered without increasing the cost of carrying every train; and the effect of assuming that the trains are all full, when a portion af them is not full, will evidently be to render the estimated increase of cost consequent on the gradient somewhat higher than it really is. The formula is intended to give *a limit* within which the actual value of the gradient must always be found; and as it should be the object of every company to do their transportation with the least possible labor, and at the least possible cost, the number of miles actually travelled ought to approach very nearly the number corresponding with the assumption of full trains; and, consequently, except in extreme cases, the estimate should not be much in excess.

Now, if the limiting gradient of the road be changed, the number of miles travelled by the locomotive engines will also be changed. If the load be reduced one half by the introduction of any plane,

the number of trips, and, consequently, the cost of locomotive power, will be very nearly doubled by the admission of that plane.

The number of miles travelled by the engines in the course of a year, snpposing them to convey full loads, and the transportation, accordingly, to be effected with the greatest possible economy of power, will be expressed by

$$\frac{2\,T'}{n}=N,$$

where n is put for the average *gross* load in tons, up the limiting grade, and T' tor the *gross* weight in tons carried one mile in the direction to which that gradient is opposed.

We know from satisfactory experiments, that an inclination of 20 feet per mile, on a road in good adjustment, requires for its ascent a power nearly double, and one 40 feet per mile, a power treble, and one 60 feet a power quadruple, (or, for grades under 80 feet, very nearly in this proportion,) that which is required to draw the same weight on a level. In other words, if W be the gross load an engine is capable of drawing with safety and certainty on a leve, road, and x the inclination in feet per mile of the gradient which limits the road, then

$$\frac{20}{20+x}W=n$$

will be the load, near enough for our object, with which it can ascend the plane rising x feet in a mile.

If we now designate by C the cost of running the engine with its tender only, one mile; by c the additional cost of motive power per mile, due to each ton gross added to the load,—then $C+cn$ will be the whole cost of motive power per mile run. This sum may be written

$$C+c\frac{20\,W}{20+x}$$

by substituting for n its value expressed in terms of the grade and the power of the engine.

If we now multiply this sum by $2\,T'\,\frac{20+x}{20\,w}$, the number of mile that ought to be travelled by all the engines in the course of a year, we shall obtain for the whole annual expense of motive power

$$2\,T'\,(C\frac{20+x}{20\,W}+c)$$

and for the whole annual cost of maintaining the line and accommodating the trade which it receives

$$2\,T'\left(C\,\frac{20+x}{20\,W}+c\right)+\frac{14\,T}{1000}+500\,h \qquad (B)$$

in which we have the cost of transportation, with the greatest attainable economy of power, cleared of the number of miles traveled by the engines, and expressed in terms of the particular grade which controls the cost of power.

In order to determine the sum which we might expend for the reduction of this limiting radient, which is the problem under consideration, we must ascertain the value of this formula for different values of x, and take the difference between those values.

Let us now suppose x to assume the new value x'; the correspondihg difference produced in the aggregate annual expenses by the change of gradient, supposing still that the trains are full will be

$$C\,T'\,\frac{x'-x}{10\,W} \qquad (C)$$

The increase of of expenses is proportional to the increase of the sine of the angle of inclination of the gradient; and directly proportional to the aggregate gross tonnage which ascends the limiting gradient; and reciprocally as the power of the engines capable of runing one mile at the assumed cost of locomotive power.

The value of gradients, or the expenses whice they produce on railroad lines, will diminish, therefore, proportionally to the improvement in the power of the engines.

Let us now substitute for C its value—$\frac{3}{10}$ of a dollar—and put $x'-x=1$; and we shall obtain

$$\frac{3\,T'}{100\,W} \qquad (D)$$

for the increase of the annual expenses of a road consequent on the addition of one foot per mile to the acclivity of the limiting slope.

It is not easy to assign the proper measure of the power of the freight engines now in use; but if we assume 300 tons gross for the maximum load on a level at all seasons of the year, of engines of the medium class—from 9 to 12 tons weight—we shall not be too low for the present condition of the machine, and the average power of all good engines of that class. With this addition to the *data* of theproblem, we shall have

$$\frac{T'}{10000} \qquad (E)$$

for the an nual value, in dollars, of one foot in the acclivity of the maximum, or limiting gradient. If we now capitalize this quantity, or determine from it the original outlay of capital which would be justifiable in order to avoid an increase in the ascent of *one foot per mills*, we shall find it to be

$$\frac{1}{600} \text{ of a dollar,}$$

or $1\frac{1}{3}$ *miles for each gross ton carried one mile*—the value of money being taken at 6 per cent.

In other words, to find the value of any reduction of the acclivity of the limiting grade, on ordinary railroads, *we multiply the number of tons gross carried* UP *that gradient, by the length of the line (or by the distance seen by the engines which cross the grade in question) and by the number of feet per mile in the ascent which it is proposed to save, and divide by* 600. The result will be the value of the reduction grade, in dollars.

There is one point in this enumeration, worthy of remark, and which, I believe is never regarded in the consideration of such subjects—if, indeed, this question itself has ever received any consideration. The amount which may be paid, or ought to be expended for the reduction of the maximum gradient, *is proportional to the length of the road*, if the engines run "through," or proportional to the length of the "stage" on which the gradient is found if the line be very long and divided into stages. And this law will continue to apply until it becomes more economical to employ one or more assistant engines to aid in the ascent of such grades, in which case the value of these auxiliary engines, or the expenses which they involve, limiting the sum which may be expended in the reduction of the acclivity.

For the purpose of an application of the rule which I have announced, let us suppose that the road is 30 miles in; that the duty to be exacted of the engines is 20,000 tons gross conveyed "through" in the direction to which the limiting gradient is opposed and that the cheapest admissible line would prevent a gradient of 50 feet per mile. How much could we afford to expend, in the construction of the road, in order to reduce this summit to 40 feet? By the formula (F) we have

$$\frac{20000 \times 30 \times 10}{600} = \$10{,}000$$

The comparison of this result with the cost which would be actually required, under the circumstances, controls the location.

But if the trade in this instance had been assumed at 200,000 tons gross, the length of the line 60 miles, the value of 10 feet per mile in the limiting gradiant would have been

$$\frac{200000 \times 60 \times 10}{600} = \$200{,}000$$

The magnitude of this last result would, of course, bring up the question of the relative economy of auxiliary power, which would be wholly inadmissible in the former case. Should the comparison determine in favor of assistant engines for the limiting gradient our equation then becomes applicable again to the determination of the value of the next highest gradient, or the sum which may be expended in its reduction.

STATISTICS OF THE SOUTH CAROLINA AND GEORGIA RAILROAD COMPANIES.

The following carefully prepared comparison of the statistics of two important parallel lines of railroads will prove highly instructive and needs no other remark than that due to the industry and accuracy of the gentleman who has so kindly communicated the result of his labors to the pages of the Railroad Journal.

Receipts on the South Carolina Railroad from January 1st 1836, to December 31st, 1841.

Year.	Number of passengers.	Amount of Receipts for Passengers.	Number Bales of Cotton.	Amount of Receipts for Freight.	Amount mail storage etc.	Total Receipts.
1836	39,216	$129,982	28,497	$140,034	$ 1,598	$271,614
1837	41,554	131,283	34,395	138,269	10,663	280,215
1838	44,487	148,926	35,349	163,422	11,033	323,381
1839	37,283	190,249	52,589	204,323	28,269	422,841
1840	29,279	168,316	58,496	186,328	28,551	383,194
1841	35,141	137,928	55,665	156,328	29,475	322,741
Total.	$222,594	$905,694	261,987	$988,704	$ 109,589	2,003,986

EXPENSES

of Maintenance of Way, per Mile of Road and of Motive Power per Mile, run by all the Engines on the South Carolina Railroad, from July 1st, 1836, to December 31st, 1841.

Year,	Maintenance of Way per mile of Road				Motive Power per mile run.					Ms. run by all the engin's.	Total rec's pr mile run.	Tot. expenses per m'le ruu.	Ratio of expen's to rec'ipts.
	Timber,	Spikes,	Lab'r,etc.	Total,	Repairs of Engines& cars.	Oil and Tallow.	Fuel.	Engine and firemen.	Total.				
					cts.	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	
1836	$238 16	$ 20 53	$ 611 06	$ 869 75	74 69	6·19	12·36	11.35	104 59	124,720	217·78	240·58	114.1
1837	262 75	55 52	561 20	879 48	73·20	1·53	9·89	11.81	96 43	172,456	162·48	212·67	134·5
1838	328 97	66 35	644 53	1039 85	53·60	3·35	6·87	10.55	74 37	210,400	153·70	181.04	117·8
1839	227 23	136 93	618 04	982 20	42·74	2·38	5·57	8·81	59 50	253,104	167·06	147·39	88·2
1840	140 72	23 03	429 36	593 10	33·34	2·15	4·35	8·10	47 94	251,764	152·20	111·04	73.0
1841	168 50	13 61	365 36	347 47	27.35	1·00	3·92	7·84	40 11	253,560	127.28	96·40	75·7
Av'ge.	$227 72	$ 52 66	$ 538 26	$ 818 64	49,60	2.48	6.47	9·42	65 27	211,001	158·39	155·22	98·1

EXPENSES

of the South Carolina Railroad, from June 1st, 1836, to December 31st, 1841.

Year.	Maintenance of Way.				*Motive Power.*						Trans-porta'n depart-ment.	Salar'es interest etc.	Total expenses.
	Timber for track.	Spik's.	Superin. labor etc.	Total repairs.	Repairs of egines and cars.	Oil & tallow.	Fuel.	Engine & fire-men.	Inclin'd plane.	Total.			
	dol.	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*	*dol.*
1836	32,390	2,792	83,105	118,286	93,151	7,723	15,408	14,154		130,436	17,330	43,933	309,985
1837	35,734	7.551	76,324	119,609	126,290	2,643	17,058	20,375	9,091	175,457	24,799	57,284	377,149
1838	44,739	9,024	87,656	141,419	112,784	7,049	14,463	22,199	10,671	167,165	35,339	36,994	380,917
1839	30,904	18,622	84,053	133,579	108,181	6,031	14,086	22,306	6,670	157,274	53,732	28,454	373,039
1840	19,138	3,131	58,393	80,662	84,039	5,404	10,958	20,389	6,255	127,044	52,388	19,463	279,557
1841	22,915	1,851	49,089	74,456	69,352	2,535	9,948	19.866	4.834	106,537	42,254	21.173	244,419
Total.	185,820	42,971	439,220	668,011	593,797	31,385	81,921	119,289	37,521	863,913	225,842	207,301	1,965,066

The South Carolina Rail Road extending from Charleston South Carolina to Hamburg, a distance of 136 miles, consisting originally of a light flat oar iron lrid on a superstructure supported, except in cuts, on piles. This construction proving insufficient, after two or three years trial, the whole was rebuilt between the years 1835 and 1839; the piled portion of the road embanked, and a flat bar having a flangh projecting downwards on the inside and weighing 26 lbs. per yard substituted for the old.

The expenses in the above statements, include, the relaying of the road and the timber and spikes necessary for that purpose, but not the iron rails and embankment, for which the following sums were expended in

1836	$138,891	
1837	221,629	
1838	216,290	
1839	165,171	including $10,806 paid for land.
Total	$741,981	

The repairs of Engines and Cars include the cost of all new cars and ten or twelve new Locomotives, besides the reconstruction of five or six old ones. On 1st January 1836 the company had

16 Efficient Engines
4 Needing considerable repairs

20 in all

They have now about the same number besides such as may be reconstructing in their shops. In addition to repairs of Engines and Cars the shops do work for the road of which there is no account in the Report. All the Oil, Tallow and wood for fuel used in the shops is included under these heads in the statement, the report not furnishing the means of separating them.

RECEIPTS

On the Georgia Railroad, from May 1st, 1838, to April 1st, 1842.

Year.	Number of Passengers.	Amount receipts for Passengers.	Weight of Freight.	Number of Bales of Cotton.	Amount of Receipts for Freight.	Amount Mails, etc.	Total Receipts.
		Dol.			Dol.	Dol.	Dol.
1838	28,091	66,141	7,817,927	25,613	60,984	7,805	134,929
1839	22,632	63,505	8,818,060	47,235	101,420	19,678	184,603
1840	22,910	66,262	9,667,706	20,878	66,427	25,536	158,225
1841	22,784	71,461		40,616	118,969	33,826	224,256
Total,	96,417	267,369		134,342	347,800	86,845	702,013

EXPENSES

on the Georgia Rail Road, from the 1st. May 1838, to April 1st. 1842.

Maintenance of Way.				Motive Power.								
Year.	Lumber &c. for track.	Labor &c.	Total.	Repairs of engines.	Repairs of cars.	Oil and packing.	Fuel.	Engine and Fireman.	Contingencies.	Total.	Transportation. Depart.	Total Expenses.
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
1838	589	21,654	22,244	5,044	4,193	1,489	4,051	4,913	472	20,164	20,954	63,362
1839	1,285	15,887	17,171	4,733	4,965	2,850	6,269	8,275	4,013	31,106	21,969	70,246
1840	5,446	16,390	21,837	6,792	4,924	1,177	5,403	6,755	2,525	27,577	17,870	67,284
1841	11,933	26,759	38,692	9,611	6,115	1,539	7,187	8,815	2,861	36,126	22,700	97,518
Total.	19,253	80,691	99,944	26,180	2,0197	7,055	22,910	28,758	9,871	114,973	83,493	298,410

EXPENSES

of Maintenance of Way, per Mile of Road and Motive Power per Mile, run by all the Engines on the Georgia Railroad, from May 1st, 1838 to April 1st, 1842.

Year,	No. of mil's of road in use.	No. of miles run by engine.	Maintenance of Way per mile of Road.			Motive Power per mile run.						Total rec'ts p'r mile run.	To. expenses pr. m'le run.	Ratio of expenses to r'cts.
			Tr'ber etc.	Lab'r.etc	Total,	Rep's of engines.	Rep's of cars.	Oil and pa'king.	Fuel.	Engine and firemen	Total.			
			Dol.	*Dol.*	*Dol.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	
1838	70	89,701	8 42	309 36	317 76	5.62	4.68	1.66	4.52	5.48	21.95	150.42	70.64	47.0
1839	88	110,842	14 60	180 53	195 12	4.27	4.48	2.57	5.66	7.47	24.44	166.55	63.38	38.1
1840	105	110,540	51 87	156 10	207 98	6.15	4.45	1.07	4.87	6.11	22.66	143.14	60.87	42.5
1841	140	152,520	85 24	191 14	276 38	6.30	4.07	1.01	4.74	5.77	21.81	147.03	63.94	43.5
Av'ge.	99½	115,901	40 38	213 38	253 17	5.65	4.36	1.52	4.94	6.20	22.67	151.43	64.37	42.5

The Georgia Rail Road extending from Augusta Geo. to Madison on the main line a distance of 104 miles, has 75 miles laid with a flat bar weighing about 18½ lbs per yard and the remaining 29 miles with a T rail weighing 46 lbs. per yard. The Branches to Athens and Warrenton 43 miles in length are laidwith the flat bar weighing 18½ lbs. per yard. Upwards of 30 miles of the oldest portion of the road is said to have been completely renewed in consequence of the decay of the timber. The cost of this is included in the above statements.

The Receipts for the year 1839 are only for eleven months and in the average at the bottom of the statement, of "Maintenance of way per mile of road," $\frac{1}{11}$ of the cost for this year is added. In the other parts of the statement this correction is not necessary.

The Georgia Rail Road Company, have 12 Locomotives made by Baldwin, Vail & Hufty of Philadelphia, which it is believed are all that they have ever owned. The oldest of these Engines has cost in repairs $3500 and is now said to be as good as new. There are other Engines on the road that have run twice the distance that this one has at no greater cost for repairs.

For the American Railroad Journal and Mechanics' Magazine.]

Mr. Editor,—Having received the annexed *Official Report*, from Major Baker, Commandant of the U. S. Arsenal, at Watervliet, I offer it as an article that may prove acceptable for your Journal; and will feel obliged, too, by your insertion of it.

Your obedient Servant, Edward Earle.

To Major R. L. Baker, *Watervliet, June* 6, 1842.

REPORT

Of the Comparative Strength and Elasticity of *Mineralized* Timber, and that in the *Natural State.*

I have submitted to the proving machine 12 pieces of each kind, comprising oak, maple, birch, whitewood or tulip tree, and pine. The principal data recorded were—

1st. Deflection with the constant weight of 383 lbs. (weight of apparatus.)

2d. Greatest deflection and weight while the elasticity was perfect.

3d. Ultimate deflection and *breaking weight.* The deflection was also generally taken for every additional weight.

Five minutes were allowed for a *Set*, five minutes for a *Resili-*

ance, and five minutes between each 20 lbs. added near the breaking point.

The proof pieces were two inches square, and 48 inches of effective length, prepared in November 1840, by sawing blocks of large timber lengthwise into battens, which were carefully finished by the plane to a square of two inches, and the weight of each taken to within three grains. One half of the battens, from each prism of timber, were selected for mineralizing by taking from a map of the end every second piece over the whole area. They were mineralized in November 1840; and since that date both kinds have been constantly in store, and seem *absolutely dry*, many of them having lost from 1-6th of a lb. to 1-5th of their original weight. It is somewhat remarkable that birch has lost less than other kinds; and some pieces have increased in weight from a few grains to more than a pound.

In the oak, pine, and whitewood, the average of the breaking weight was greatest in the mineralized pieces;—equal in those of birch,—and a little less in maple. Being called to other duty, the number of proofs in maple and birch were too few to be satisfactory. But thus far, the results led to the decision that Dr. Earle's process *does not reduce the strength* of timber. The elasticity seems a little diminished in several, and, perhaps, further experiments may show some corresponding increase of strength.

TABULAR COMPARISON.

—	MINERALIZED.		UNPREPARED.	
	Greatest Deflection.	Breaking Weight.	Greatest Deflection.	Breaking Weight.
Oak	2.37	1256	2. 6	1226
Maple	1.50	1469	1.36	1617
Birch	1.00	808	1.15	1014
Whitewood .	1.55	965	1.95	931
Pine	1.25	729	0.82	589

Two contiguous battens on the map were selected,—one cured, the other raw,—and each reduced 1-8th of an inch on each face, to remove the part, if any, injured by the heat, and to render them of one size. The cured broke with 1022 lbs., the other with 988 lbs.

A number of pieces of different kinds of timber were intentionally operated on *excessively* by *repeated* and long boilings. In *all*

of these which have been tried, the strength *appears diminished* in a slight degree.

All my observations, thus far, tend to corroborate the suggestion that *boiling heat is not necessary;* and that long* digestion is important: and, to prevent checking when taken out, that the timber ought to be *cooled in the tank.*

Respectfully submitted,

(Signed) R. M. Bouton.

Extract from the last semiannual Report of T. Tupper, Esq. President of the S. S. C. and R. R. Co., who has, since last year, been using this process on the R. R. between Charleston and Hamburgh, S. C. Referring to a late advantageous purchase of timber for the road (*at one half the usual price*), he says:—

"This timber is obtained at a reduced price, as the sap is embraced in the square of the piece, and consquently taking a much less tree than when the heart only is retained.

"The advantage of this process will be felt at once in the lower price at which the timber is contracted for; and, should it only last as long as ordinary timber, no expense will have been incurred, as the difference in the price of the timber will pay the expense of preparation.

"The timber prepared four years ago with corrosive sublimate, is still sound, the sap of which has already shown a durability of double that of unprepared wood, and, from all appearance, will be sound when the unprepared is so rotten that it cannot be separated from the earth in which it is buried."

☞ Here is a most important fact ascertained,—the effect of corrosive sublimate on the sap-wood of timber;—from which President Tupper derives the practical and useful inference that the sulphates of iron and copper—which have been fully proved to affect timber in the same manner as corrosive sublimate—must also render sap-wood at least as durable as the heart is without them; and, by thus reducing the price of timber *one half*, annihilate the cost of the process. E. Earle.

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* By "long digestion" is meant a more protracted digestion than has been hitherto employed; that is, from one to two, three, or more days, according to the size, length, and kind of timber; and at a temperature short of the boiling point, or at 170 to 180 degrees F. A short boiling, of an hour or two, however, is recommended for timber of great size and length. E. E.

[From the Civil Engineer and Architect's Journal.]

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING, AT THE LONDON UNIVERSITY COLLEGE.

Lecture 7.—On curves of railways.—This lecture was devoted to the consideration of curves upon railways, and Mr. Vignoles pointed out the principles on which should be compared the economy and advantages to be obtained by the adoption of curves, with the inconvenience attending on them; the saving of expense in formation, earthwork bridging, &c., by curving round natural obstacles; the advantages of attaining a more level line, avoiding interference with valuable property, or approaching towns, mineral or manufacturing establishments, &c., all entering into the former—the practical inconveniences of additional resistance to motion and retardation of velocity to ensure safety being the set-off; and, among other elements, it was stated that the breadth or gauge of the railway affected the calculation. The Professor then showed that along very wide valleys, through champaign countries, and where the grounds undulated, so that the ridges, dividing the water courses, were successively crossed by the railways at right angles to their general direction, the saving by lateral deviation would seldom be material, and consequently, that the curves may be laid out so flat as to be practically equivalent to straight lines—the "*accidens de terrain*," to use a French phrase, being, in such districts, to be overcome by cutting and filling, to the extent justified by the importance of the line and traffic, or by the introduction of undulating gradients, somewhat approximating to the natural surface of the country. But in tracing a line of railway along the sides of hills bounding narrow valleys, particularly where the main valley is broken by lateral rivers, then the economy from curing becomes very great, and the introduction of curves to the greatest possible extent, consistent with safety, is allowable.

Mr. Vignoles then went on to consider the various means employed to obviate the practical inconvenience arising from curves on railways. He began by explaining the peculiar distinction in make between carriage-wheels and axles constructed for running on railways and those for common roads—in the former the wheel being keyed fast to the axle, and both moving round together—in the latter the axle being fixed to the carriage, the wheels only moving round. Many attempts had been made by engineers to give the railway vehicle the advantage which the road carriage had of turning with facility and safety round sharp bends, but in vain, as the wheels always got off the rails laterally, at even moderate velocities; it was only on the old tramroads that the wheels were loose on the axles. Railways wheels being thus fixed to the axles have the tendency to move on a straight line, so that on the occurrence of a curve the effort to continue in motion in the direction of the tangent of that curve creates a certain degree of resistance, as the wheels are only kept upon the rails by the flanges pressing against the inside edge of the outer rail of the curve. The professor then entered into a number of technical details, which he illustrated to

the class by diagrams, explaining why the flange of the wheel had now, by common consent, been placed on the inner side or the periphery of the wheel rather than on the outer side; and also the reason for allowing a certain amount of play, being the difference between the gauge of the rails and the gauge of the wheels, and the manner and cause why the rim of the railway wheel is made somewhat conical—that is, the wheel, instead of being quite cylindrical, is really the frustrum of a cone—stating at the same time, the rule for giving the proper "cone" to the wheel, being dependent on the *minimum* radius of curvature on the line to be travelled over, and the *maxinum* velocity. In general, the "cone" was stated to be about one-seventh of the breadth of the rim of the line, giving about one inch for the difference of diameter of the wheels at their inner and outer edge, for, when carriages are passing round a curve, the wheel and axle, being connected, roll together as a rigid body, and require the contrivance of the "play and the cone" to prevent too much lateral friction of the flange, and to get the wheel round the curve without dragging. Mr. Vignoles then showed that on the ordinary railway gauge of 4 ft. 8½ in., and in the 3-feet wheels, the above amount of cone and play would be sufficient to meet a curve of only 200 yards radius, which is greater than any which ought to be laid down on a travelling line for high speeds.

The centrifugal force due to the velocity of the carriage was next to be considered. As before stated, its tendency in moving round a curve is to keep a tangential course; this force may be accurately computed (being dependent on the velocity of motion, weight of the carriage, and the radius of curvature) by well-known formula, whence is deduced the fractional part of the weight of the carriage, representing the contrifugal force. The Professor gave the formula, and worked it out on a supposed velocity of something more than 17 miles per hour, or about 25½ ft. per second, on a curve of 200 yards radius, whence the centrifugal force was found to be 1-30th of the weight of the carriage. Mr. Vignoles quoted the following rules—viz., "multiply the square of the velocity in feet per second by the gauge of the railway, and divide the product by the accelerating force of gravity, multiplied by the radius of curvature in feet," which gave an expression, which, though not the fraction of the weight, was what would do very well for practical and ordinary purposses; it was the height which the outer rail of the way should be elevated, to counteract the centrifugal force, and prevent the wheel flying off at a tangent to the curve. He then stated M de Pambour's more strictly mathematical, but more complicated, rule for obtaining the same amount of elevation of the outer rail, and showed the table of results calculated by that engineer and by Mr. Wood, of which we only give the extremes, by which it appears that, supposing it safe to encounter so sharp a curve as one of 250 feet radius, at the rate of 30 miles an hour, the outer rail of the way must be elevated 12 inches; but for a radius of 5000 feet, or nearly a mile, at the rate of 10 miles per hour, the requisite elevation is only 1-16th of an inch. Having

elevated the outer rail, the axle of the carriage, resting on the two rail, gets such an inclination as will produce on the load a gravitating force inwards equal to the centrifugal force outwards; and there will neither be any tendency in the carriages to upset or to press the flanges of the wheels against the rails. The rails once laid, if the carriages run slower than the calculated rate, the centrifugal force is overbalanced by gravitation, and the flanges of the wheel press the inside rales; if quicker, the contrary effect takes place, and the flanges press against the outer rails, so that some medium rate of travelling must be fixed on; and, as the slow trains are in general most heavily laiden, any increase of friction has a more powerful effect of retardation than will occur to lighter loads moving at greater speed. Mr. Wood, therefore, advises that the outer rail should not be elevated more than will compensate the centrifugal force produced at the slower rates of motion with heavy trains. Mr. Vignoles then forcibly illustrated the practical effects of neglecting these rules.

He then entered on the subject of laying out curves on the ground by a succession of set-offs at the end of each length of any given measure—the set-off being calculated from the radius of curvature considering the given measure (say a chain length) as the side of a circumscribing polygon; and, on the large scale, and practically, a number of these sides of a polygon become the segment of a circle. Mr. Vignoles gave a simple approximate rule for finding the set off from the radius, or the reverse, by "divide the number 792 (the number of inches in a chain) by the radius in chains—the quotient is the set-off per chain in inches." Thus, the set-off per chain for a curve of a mile radius is 9.9. or, in round numbers, 10 inches. When the curve is of less than one mile radius, it is advisable to make the sets-off by half-chains. It was observed incidentally by the Professor, from the same rule, she set-off due to the curvature of the earth was, in round numbers, about eight inches per mile, and hence had arisen formerly some curious engineering mistakes, from supposing that a horizontal line was a tangent to the earth's surface; and, in setting out canals, an inclination of eight inches per mile had more than once been given to the water line, while it was imagined it had been laid out for a dead level. In conclusion, Mr. Vignoles mentioned that some further observations on curves would occupy the next lecture.

Leciure 8.—*On curves.*—In continuation of the subject of curves, Mr. Vignoles explained that in many cases it was impracticable or inconvenient to apply, on particular ground, the approximate rule given in the last lecture, of setting out curves chain by chain, or other short lengths, making each the side of a regular polygon, the set-off being constant. In that method the given length was strictly a secant, and not a tangent, to the curve. Another formula was more generally applicable, and sharp curves on hill sides, through thick woods, had been quickly and accurately set on therefrom. It was this; $offsett = radius - (radius - tangent)^{\frac{1}{2}}$; the demonstra-

tion of this was given, and illustrated by a diagram. For the field tables calculated beforehand, for the greatest number of usual curves should be prepared; but, on the occurrence of any peculiar cases, the calculation could be very readily made, with the help of a pocket table of natural sines. The Professor then recapitulated some of the leading points that had been gone over in detail at the last lecture observing that on the three principal expedients for counteracting the injurious effects of curves, the usual measurements might be easily remembered—viz., half an inch for the "cone" of the tread of the wheel; one inch as a *maximum* amount of "play" of the wheels between the rails (it being disadvantageous to allow too much play ;) and one inch for the extreme elevation of the outer rail in laying the way, that being the measuredue to a velocity of 25 miles an hour, on a curve of half mile radius. Mr. Vignoles then observed that the "cone" being given to the wheels, on account of the curves, when the line of road was perfectly straight, this conical formation of the tuyere was not required, and the general disadvantage of such a form of wheel, not bearing upon the whole face or upper bottom of the rail, preponderated. It had, therefore, become customary to incline the rail, to meet the cone of the wheel, and this should always be done, both, on straight lines and on curves whose radii are not small. This inclination of the surface of the rail is obtained by casting the receiving chair accordingly on rails; having a continuous bearing on longitudinal sleepers, or bearing direct on cross timbers, without the intervention of chaies, the wood is cut to the requisite angle; or the inclination is sometimes given to the rails in passing through the rolls. Without this precaution of inclining the bearing surface of the rail to meet the cone of the wheel, the edge rapidly wears, and the laminæ of iron peel off in strips, more or less, according to its quality, and there is no more critical test of the perfection of rolled iron rails than the manner in which the bottom edges go through this ordeal. With the above precautions of "cone," "play," and elevation of the outer rail, the resistances opposed by curves to a single carriage may be considered to be practically annihilated; but when the trains become very long, there must, of necessity, be a considerable lateral action and grinding, from the change of direction of the original drawing force through a number of carriages; but Mr. Vignoles stated that although no conclusive experiments had been made to show the exact amount of resistance from this cause, his own observations and experience led him to conclude that the degree of curvature on railways might be safely extended further than they have hitherto been laid down on principal lines.

Mr. Vignoles referred to former observations of his, that the public would be better accommodated by more frequent departures of smaller trains, and that with such trains the curves would be of still less importance, adding that it could only be by the introduction of greater curvatures to save expense; and, as he had repeatedly argued for the same reason, by the adoption of steeper gradients, that the benefits of railway communication could be ex-

tended through many districts, and to the more distant parts of the country, as on the most economical principles of construction, Mr. Vignoles referred to the report of the Irish Railway Commissioners, and to the works of Mr. Wood, M. de Pambour, Lieut. Lecount, and other writers, for further details on curves, observing in conclusion of this part of the subject, that where curves are so quick as to require it, especially in crossings, the additional precaution of guard rails becomes expedient.

In adding a few words on the subject of coupling carriages together in a train, the Professor insisted strongly on the draw-boys being always in the centre, and observed that, as a general rule, the connecting links should be screwed up as stiff as possible consistent with the curves of the railway, as otherwise the carriages are apt to swing. He mentioned that the best coupling was that of Mr. Henry Booth, the talented manager of the Liverpool and Manchester Railway from its very first origin. But, as a general form of combining the draw-boys and buffers on a central rod or tube with spiral springs acting solely from the centre, Mr. Vignoles spoke in the stronges terms of the apparatus of Mr. Thomas F. Bergin, the manager of the Dublin and Kingstown Railway, on which line they had been used with advantage for a number of years.

Lecture 9.—*on tunnels.*—In proceeding to treat of the subject, which might be termed that of the great works of art, to be introduced in the formation of roads or canals, but particularly of railways, Mr. Vignoles said that it would not be possible in the lecture-room to go into the details of the constructions, but that he must limit himself to general principles. The rules for consideration when such works ought to be adopted were sufficiently simple; for example, to determine where tunnels should be substituted for open cuttings, or viaducts for embankments. The French engineers who are in general very much better mathematicians than we are and probably, from that very circumstance, more inclined to be theoretical, are much in the habit of introducing formulæ which, often very useful, are not always readily applied by the practical men of this country. Supposing it to be required to determine at what point on a longitudinal section (for road, railway, or canal,) it is advisable to begin to tunnel, instead of continuing a simple excavation—that is, the point where it becomes as cheap to tunnel as to cut open—for such a case the following formula is given by an eminent French engineer:—Let x=depth of cutting; l=breadth of road, railway, or canal, on the travelling surface; a=depth of bed, of road, or railway, to be first excavated, and afterwards filled with road material or ballast; or depth or canal below the water-line; $\frac{x}{m}$=slope of excavation; p=price of the cutting per cubic yard. The expense of excavation per yard forward of the sectional area of any cutting will consequently be $ap+p\left(lx\frac{x}{m}=x\right.$; and, when

this price exceeds the price per lineal yard forward of tunnelling, the latter is cheaper, supposing the given prices to cover all risk and contingencies in each case. But, as circumstances are continually varying, the English engineer so repeatedly finds that he has to modify—and perhaps finally abandon—the general theoretical rule, and fall back on his own experience, and that of the contractor he may be disposed to employ, that, although he may occasionally resort to such a formula as an approximation, he ceases to employ it in practice, and obtains the sectional area of the given cutting in superficial yards, by simple mensuration, and multiplies it by the price. All the complex condition involved by slips, faults, water, and the numerous incidental occurrences in great works, to occasion unforeseen expenses, render prices uncertain, and prevent any fixed general rule; and it is only when the materials and probable contingencies are perfectly well known, that the element of cost can be safely introduced into the mathematical formula. For dry indurated sands, gravel, sandstone rocks, &c., calculations may be made within probable limits or error; whereas, in many instances where the theoretical rule and general opinion, even of those sufficiently experienced, would recommend tunnelling, it has been tried in vain, abandoned after great expense in contending with water, and recourse had after all to open cutting. The average cost of tunnelling upon the principal railway lines, as actually executed, appears to be about 60*l.* per yard forward, in some instances as much as 100*l.*, especially when driven forward in reckless haste, and in attempting to sink shafts or drive driffs, without due consideration as to the quantities of water in the various strata, or the means of at once grappling with the difficulties of drainage or pumping. With great facilities, favorable material, and not too much hurried, the same area of tunnel has been driven for so little as 20*l.* per yard forward. In round numbers, and on an avarage the sectional area of the ordinary tunnel for a double line of railway, to be worked by locomotive engines, may be called 50 superficial yards when finished, or within the ring of brickwork or masonry, if lining were required; in this latter case, the sectional area of the opening to be assumed as about 80 superficial yards. Mr. Vignoles observed that, for future tunnel operations, with the benefit of past errors and experience, by avoiding undue haste in execution, and with sufficient caution and activity, 40*l.* per yard forward for tunnelling may be taken as an avarage approximate fair price. Now if it were wished to compare this expense of tunnelling with the cost of open cutting, the Professor observed that, from his experience, which had been very considerable, in removing earth in large quantities, he was not disposed to put a less price than that of 1*s.* per cubic yard for removing materiel for deep excavations, especially when this price is to cover contingencies of slips, &c.; with such a price, then, an open cutting 55 ft. deep, roadway 24 ft. wide, and soil requiring slopes of two horizontal to one perpendicular, would give a sectional area of 800 yards—that is, the expense (in estimate) would be the same as that

of tunnelling. But Mr. Vignoles observed that, in addition, the future maintenance of the tunnel should be taken into consideration, as well as whether the material from the cutting could be disposed of with advantage; the nature of the soil, and a varity of other circumstances which he stated, all of which would influence the decision. In soft rock, which would work with facility, and yet stand nearly perpendicular, the depth might be very much greater than 55 ft. before tunnelling would be cheaper. In such cases, a depth of 80 ft. and upwards had been resorted to. In chalk the proper slope to be given, which was very variable, would greatly alter any elements of calculation, while, on the other hand in forming tunnels through chalk, experience had shown that water was the great enemy, and had entailed enormous expenses. The Professor went into a great many othor points for comparing excavations with tunnelling, but they appeared too technical to be satisfactorily explained in a brief abstracts such as this.

On Viaducts and Aqueducts.—Mr. Vignoles next proceeded to the consideration of viaducts and aqueducts, into which, he observed, a totally different set of conditions enter, the cost varying from 20*l.* per lineal yard to the price for which no rule could possible be laid down. Viaducts such as that of which the London and Greenwich Railway wholly consists, may, probably, be executed for 20*l.* to 30*l.* per yard, including the foundations. Of course, the foundation entered materially into the calculation, and where water had to be crossed, largely increased the expense. In some peculiar instances, a large river viaduct, or bidge, has cost as much as 200*l.* per lineal yard. The Professor instanced a viaduct he had built over the river Ribble, at Preston, for the North Union Railway. The length was 300 yards, the height about 45 feet above the water, and the whole mass, including concrete foundations (where the rock was not attained,) comprised about 25,000 cubic yards; cofferdams were used for the piers, and for one abutment. The bridge consisted of five arches, each of 120 feet span, batiring on the face and spandrils from the parapet to the impost course—roadway about 27 feet wide; the total cost, including all contingencies, was £45,000, which is 150*l.* per yard forward, or 30*s.* per cubic yard on the whole solid contents; this might be considered a low price, inasmuch as an ordinary brick bridge, of twenty to thirty feet span only, and with facilities for construction, can seldom be built for less than 20*s.* per cubic yard. Where no water or expensive foundations are to be encountered, and where the spans of the brick or stone arches do not exceed about 60 or 70 feet, 1*s.* per cubic foot on the solid contents of the viaducts may be put as a good covering price. Mr. Vignoles stated that, for such viaducts, about 60*l.* or 70*l.* per lineal yard might probably be taken as the average approximate cost, and the additional expense, from a considerable increase of height, does not become so very great, as it chiefly affects the piers only. The Professer then enlarged much on adopting timber arches with piers of masonry, for viaducts of large span and great height,

and produced a number of drawings of such bridges, some actually constructed, and some only proposed. The heights were from 70 to 150 feet, the *minimum* price being 35*l.* and the *maximum* 80*l.* per lineal yard. He further pointed out that high embankments should be avoided, and timber viaducts substituded, as a mere point of economy, even without taking into consideration the risk and danger of slipping in such great masses of earth. In an embankment only 40 feet high, an occupation bridge for a farm would often cost nearly £1000; it was, therefore, only in crossing a very narrow valley or ravine, where no bridges under would be called for, and no masonry—except perhaps a culvert of the very smallest dimensions—that very high embankments should be made. Mr. Vignoles alluded to several such, varying from 70 to 90 feet high, which he had made, and pointed out a terrible failure in one case although in other instances success had followed. In passing through hilly countries and along mountain sides torn by ravines, the introduction of the timber-tod viaduct, with stone piers, to overcome points of great but partial difficulty, was strongly recommended, especially as great additional height of virduct could be given at small expense, and thus excavations on each side saved.

REPORT

To the Stockholders of the South-Carolina Canal and Rail-Road Company:

In conformity with the rules and usage of the Company, we present to the Stockholders the accounts for the half year ending 30th June, 1841, with such remarks on them, and the general interest of the Company, as seem necessary to give the most correct understanding of its affairs.

Soon after the annual meeting and semi-annual report in January last, the Board thought proper to reduce the rate of passage on the road from 7½ cents per mile to 6 cents per mile as an experiment, believing an opinion very generally held, that reduced rates would increase the receipts of the road; but thus far it has not produced that effect, although a greater number of passengers have passed on the road in this than in the same months of last year—the receipts have been $19,000, or 21 per ct. less.

The rate of freight too, has been reduced, to accommodate the public, to about three-fourths of what was charged the early part of last year, which accounts for the small amount received, compared with that period. The accounts of the Secretary and Treasurer herewith marked (A.) show that the receipts from 1st January to 1st July, instant, amount to - - $158,992 12

And the expenditure, - - - 124,743 55

$34,248 57

Making the nett income less 1⅓ per ct., notwithstanding the expenditure is $27,470 25 less than

the corresponding months of last year. But, had the receipts of this six months equalled that of last year for the time, say 1st January to 1st July, 1840.	$223,295 46
And the expenses the same as now,	124,743 55
The nett income would have been	$98,551 91

Nearly 5 per ct. for six months, or 10 per ct. per annum.

A reduction of rates below that which will yield a fair remuneration for the out-lay of capital in an institution of this kind, is not only injurious to the parties immediately concerned, but does injury to other establishments in the same business, and thereby produces mischief to the whole carrying trade of this section of country.

No corporation can be considered as well managed, where the public or individual interests are made paramount to that of the corporation.

We think it proper, therefore, that such tolls be charged as would return a fair interest on the capital employed, calculating an ordinary amount of traffic and tarvel, and trust to the good sense of the community to give a generous support, especially where it can be made to appear, it is their interest to do so.

An opportunity lately occurred, which proved to this city the value of our road, which could not be felt so sensibly by the continual use of it. We refer to the late freshet, when the trade was broken off with the country about one week. During this time the business of the city was almost entirely suspended, and animation only returned when the road was re-opened for transportation.

Early in March last a flood came which stayed the transportation for several days, and so injured the road that the repairs are not yet fully made in a perfect manner, having been first done in a temporary way to prevent a delay, as far as possible, of passengers and goods. The expense of these repairs will not be heavy—say about $5,000, which leaves the expenditure of this half year considerably less than the same period of 1840, viz:

January 1, 1840 to July same year,	$152,213 80
The same time this year,	124,743 55
Leaving,	$27,470 25

This saving has been in reduced wages and lower price for supplies, and a less amount of machinery and materials required.

By a comparative statement appended, marked (F.,) it will be seen that many of the items in the expense accounts are lower this year than in the last; and that all of those higher, are swelled by the extra repairs of the road after the late freshet, except coal, of which we had purchased largely at a low rate.

Wages for the road, notwithstanding the large number of hands replacing embankment, (about 80,) for the last three months, is $925 less than last season.

The additional force will be contined some time in refilling the road where the embankment has settled since first made, and would have been done before this, were it not that before the repairs of

the effects of the great freshet of May, 1840, were fully completed the freshet of last March made a demand for a large amount of labor. The whole surface of the road will soon present a more perfect finish than at any time past, and will, before October next, if not interrupted, by any extraordinary occurrence, be completed agreeably to the plan contemplated for the general improvement of the road resolved upon in 1836.

Great facility of repairs has been obtained by the use of the locomotive engine in removing earth; where the haul is more than half a mile, the saving is fully one half. The Four Hole Swamp has been refilled near the centre, where the haul was about one mile, for not over ten cents per yard, by the application of steam power, saving more than double the cost of the wooden road over the swamp, had the whole been originally filled in the same way. It was calculated by the contractor who constructed the embankment over this swamp, that the use of the *road on piles* was equal to the cost of it, ($4,500,) merely in filling the track by horse power and barrows; and by steam power double that amount is saved.

The hauls on the whole road would average much less, but it is safe to say, that more than half the whole cost of a wooden road on piles through a route like ours, would be repaid by the advantage gained in using it with locomotive power in filling the embankment. But the greatest benefit from a piled road is the preservation of a perfect level, and sustaining the rails when the embankment is washed.

The advantage of substituting locomotive for stationary power at the Inclined Plane is now fully developed The saving cannot be less in fuel, labor, superintendence and interest on capital employed, than $3,000 per annum.

The superintendent and labors are not employed in passing trains more than three or four hours in the day—the remainder of the time they are repairing road, cars, &c.; and the engine, when required to do so, takes passengers and freight to and from Hamburg. Five negroes and three white men, including master carpenter, have been dispensed with from 1st July, employed before in repair of buildings, &c. A brick building for work-shops, with tin roof, has been completed there, which is quite fire proof, and two large wooden buildings, taken down; another, the last of wood, to be taken down in the ensuing year.

There is no subject of higher interest to this Company, and others owning rail-roads, than that of preserving timber from rot, There are two modes that have particularly claimed the attention of the public within the last three years.

The first is that of Kyan in England, called Kyanizing, which process we have experimented upon the three years past, and reported the progress semi-annually, which will continue here.

"On the 9th day of July, 1838, four pieces of rail timber, all cut from one stick, each six and a half feet long, and about nine inches square, were put in the road as rails. Two of these pieces were prepared in a solution of corrosive sublimate about fifteen

days. The other two pieces were not prepared," These four pieces were all nearly covered with the earth to the top surface, where they remained, daily passed over by trains of cars, till July 1st, 1841, when they were taken up and examined by a Committee of the board consisting of the president Col. Gadsden, and Dr. Johnson; and Mr. Ross, Master of the Workshops, Mr. Lythgoe Superintendent of the road, Mr. Jas. F. Edwards and Dr. A. Gadsden, were also present.

The Kyanized pieces were perfectly sound, the sap as well as the heart, the former retained a strength and elasticity equal to a green piece of timber. The unprepared sticks were quite rotten. The sap of one, and the sap and part of the heart of the other, so much decayed, that it was believed they would not answer to remain in the road another year; consequently, the four pieces were all removed and placed in the ground at the west end of the pattern shop, the unprepared pieces nearest to the shop, there to remain for future annual examinations.

We have been thus particular in stating the above facts, and mentioning the persons present, that they, as well as others, may feel curiosity enough, or, we should say, sufficient interest in the experiment to attend the examinations as many years as they may, by circumstances, be permitted to do so.

One hundred and thirty pieces of prime timber, all twenty feet long and ten inches square, and Kyanized as above, were placed as cross-ties under both tracks of the Inclined Plane, at Aiken, supporting joints of the rails, laying about twenty feet apart the whole length of the plane. They were put in the road about two years ago, and to this time are perfectly sound,

Fifty other pieces Kyanized at Summerville, were the same year 1839, put in the road as ties on the 23d mile, and the old ties left by the side of them that they might be the better designated.—These also are yet perfectly sound. The sap of pine generally thus exposed, shows signs of decay in eighteen months or two years. There are some exceptions, however. Where the timber is put in the ground quite green, and the earth rammed about it firmly, it will remain sound four or five years, and perhaps much longer.

In March, 1837, about three-fourths of the 129th mile of our road was broken up to change the grade, and re-built with green timber, the cross-ties entirely covered, and the rail imbedded in the earth to the top, and the earth well rammed. This timber was generally quite sound, especially the ties. The sap of some decayed—none, so much so, as to require removal. One of the rails which appear to have a wind shake when put in, was condemned; the first piece removed for the four years and four months, since laid to the day examined by Mr. Lythgoe, Superintendent of the road, and myself, on the 10th instant. But it will be proper to state, that none of these pieces showed that perfect, sound surface, which the Kyanized wood presented. On the contrary, the outer

surfaces were generally cracked as if burnt about half an inch deep which was no where discovered on the prepared pieces.

The other mode of preserving timber from rot, has been introduced by Dr. Edward Earle of Philadelphia, formerly of Savannah. Dr. Earle's process which he has had patented, we will call *Earlizing*. It is much cheaper than Kyan's mode, and, if equally effectual, has everything to recommend it in preference to the other process. The cost will not be more than one-quarter or perhaps one-fifth that of Kyanizing—and it is an American invention. These secure interest and patriotism to our countrymen. We have been some time in correspondence with this gentleman, endeavoring to persuade ourselves of the propriety of inviting him to visit this State for the purpose of preparing timber for our road.

The Doctor has presented such evidences as he possesses of the value of the preparation he uses—and, as far as time admits, they are very satisfactory; but the experiments have only had about two years trial. The most important one is the pavement in two streets in Philadelphia—one prepared with sulphate of copper and iron, (Dr. E's process,) and the other unprepared. In a report of the Commissioners of the streets, it is stated, that all the prepared pieces perfectly sound; but that many of the unprepared, are quite rotten, requiring to be replaced with new.

The timber in these pavements are of Hemlock, a kind of wood that rots very soon when exposed to the weather.

A Committee of our Board have this subject under consideration and are collecting information from abroad. Col. Gadsden, one of the Committee, is promised the result of experiments making by the Ordnance department, which we hope soon to be in possession of.

If this process would preserve the timber in our road ten years, Mr. Lythgoe the Superintendent calculates there would be a saving of over sixty-six thousand dollars in the first five years, beyond the extra labor and materials required to rebuild the road in three years, usually done in five years. This sixty-six thousand dollars would more than pay the cost of Earlizing; and after five years, the saving in labor and materials would be over forty-five thousand dollars per year, as long as the timber remains sound.

Could our *pines* be made indestructible in exposed situations certainly for ten years, with the prospect of greater durability, at a rate so cheap, about two dollars and fifty cents per M. board measure, or three cents a cubic foot, our forests would be more valuable than the iron mines of any country. We say, the pines, because they can be more readily procured than any other timber, particularly when great size and length are required; and when prepared, would be at a less cost than any other timber used for building—for the land or sea service.

We have to congratulate the Company, that the expense account of each department of our establishment, is considerably less than by the report of last July, and all in better condition for effectual operation,—

The road acc't less by,	$5,188 09
The Machinery,	12,366 24
Transportation,	7,448 58
Contingent expense,	2,467 35
In all,	$27,470 25

All of which is respectfully submitted by

T. TUPPER, *President.*

Charlestown July 19, 1841.

NOTE.—In the printed report for July 1841, statement D the number of passengers for the 1st half of 1841, is printed 13,611 in place of 17,977,—and in the two succeeding reports for Jan. and July 1842 statement D the number of passengers for 1841 is printed 30,775 in place of 35,141. This will explain the difference between the original report and the tables now given.

THE RAIL ROAD WESTWARD.—Two of the seven ship loads of rail road iron required for the completion of the Baltimore and Ohio Rail Road to Cumberland, have very recently reached this port. The quantity embraced in these two cargoes is upwards of thirteen hundred tons; the five cargoes yet to arrive comprise an aggregate of some twenty seven hundred tons—making, with those just received, an aggregate of over four thousand tons. The rails are of the heavies and most durable of the kind, and of a form much approved. A gratifying evidence of the earnestness of the company to complete the road to Cumberland as speedily as possible, is shown by the fact that in twenty-four hours after the first cargo reach the wharf, a portion of it was in the hands of the contractors beyond Hancock, about 130 miles from this city. Since the rails have been sent to the western terminus of the finished road at the rate of what is equivalent to about a mile of track per day, and as the entire line to Cumberland is ready for the reception of the rails, they are in the course of being laid down very nearly if not quite as fast as they reach their destination. If no unforeseen occurrence interferes, the important object of opening the Road for travel and transportation to Cumberland will be achieved in all the month of October. In anticipation of this event it will be seen by the annexed paragraph that preparations are being made on an extensive scale for an active and efficient prosecution of the enlarged transportation business which will be then carried on between Baltimore and the West.

From the Cumberland Civilian, August 19.

WARE-HOUSES.—Four extensive brick buildings are now under construction at the Depot of the Blatimore and Ohio Rail Road, at Cumberland. They are severally intended for forwarding and commission merchants, under the following firms:—Talbot Jones & Co., Hollyday & Edgerton, Atkinson & Templeman, and Dilly & Edwards. The completion of the road to this point, this fall, is confidently calculated upon, by which time it is intended to have these ware houses finished, to accommodate the anticipated trade which this great work will afford.

The results which have been realized in the few months since the Railroad has been in operation to Hancock, have been of the

most gratifying character. The travel to and from the West has been doubled, having been attracted to this route by the superior advantages of comfort and expedition which it presents over others; and there can be no doubt that when the Road is open to Cumberland, so that the trip between Baltimore aud Wheeling or Pittsburg can be easily made in twenty four hours, or probably less, the question of the course of travel between the East and West will be settled definitively and permanently in favor of this Great Central Route: There is no other that can come into competition with it in any one of the prominent particulars of expedition, comfort or economy, and it must therefore *command* the travel between the Atlantic States and the vast valley of the Mississippi.

Correspondence of the Savannah Georgian.

LEBANON, COBB COUNTY JULY 14.

To the Editor of the Georgian—

SIR,—Major Bulloch has requested me to send you some particulars concerning the mineral resources of this section of country. My attention was first attracted by the abundance of *iron ore* I soon found in Cass county, and to this my remarks will now be confined.

The Allatoona hills mark the boundary between the primary rocks of the gold formation and the great limestone formation to the north west. The situation therefore of this range of hills bordering on granite and calcareous rocks shows at once that veins of different ores are likely to be found along and near the line of contact of the two rocks; and in no place have I ever seen this observation more strongly confirmed. On the north east side of these hills is the range of the gold veins running north east and south west, in a belt of country of unascertained width; while on the north west side, nearer the limestone, are huge beds of brown hematite iron ore running in the same direction. The extent of these beds of iron ore, as far as they have come under my observation, are at least forty miles; they are seen crossing Sharp Mountain and Long Swamp creeks, in the northern parts of Cherokee county, and thence passing to the south east, cross the Etewah river, in the neighborhood of the rail road, and so into Paulding county, and how much further in that direction I know not. At several points in this range I have carefully examined the beds to ascertain their thickness and the quality of the ore, which is found to vary very much. Much of it is a rich brown hematite, occurring in the various forms that ore is well known to take, stalactical, mammillary, botryoidal, &c., and this passes into a silicious ore, and thence to quartz rock, which is the formation comprising the veins. A grey specular iron ore also occurs, and some which is volitic, and some micaceous iron ore. The hematite is well known as the ore which makes both the Salisbury iron and the Juinata iron, both of which are the most highly esteemed for bar iron of any metal manufacture in the United States. The varieties of ore will enable the manufacturer to obtain any quality of iron desired

either for castings or bar iron, and in some localities there may be obtained on a single lot, on others the greatest abundance of the rich hematite, this latter ore I have seen in beds that from surface indications, (that is the whole surface on their outcross being entirely covered with loose masses of ore along the range of the bed,) I am satisfied must be at least one hundred and fifty feet thick; they pitch at different degress of inclination between the quartz rocks, and are *beds* (not nests or pockets) in that formation of unknown depth. Where the beds have been uncovered, the ore is wrought by blasting, like an open quarry. This is for one little furnace near the Etowah, the only furnace in operation in the Cherokee county.

I have examined the iron mountains of Missouri, have traced out the beds so boastingly described by Featherstonhaugh as "sufficient to supply a nation's wants," but can truly say I was much more struck with the importance of these vast mineral beds, which contain a rich and easy ore to work, situated in a fine farming country in the immediate neighborhood of a great limestone formation, of good water power, extensive and almost untouched forests, and yet on rail roads, and on water communication into the southern parts of Alabama and Georgia.—The Iron Mountain ore is a very difficult and refractory ore to work, and though it yield seventy per ct. of metal it is never found so profitable as a lighter ore like the hematite yielding from forty to sixty per cent. It is in a barren country thinly timbered, very rough, near no water power, and eighty miles from the Mississippi river. *This* is in the midst of a fertile country fast settling up, where the demand for iron is now great, and rapidly increasing and possessing every facility desirable for the profitable manufacture of iron. Bituminous coal is found on the line of the rail road in Tennessee about sixty miles from the Etowah river. If that prove of a suitable quality for coking, it may some time hence be advantageously transported to the furnaces but for a long time to come it will be more profitable to use the timber so abundant near the oar, particularly as the iron made with charcoal is always of a superior quality to that made with either coke or anthracite coal.

The furnace now in blast cannot supply the demand for iron. Much is brought in wagons from the furnaces in North Carolina, and sold at a price which would afford great profits to the smelter in Georgta.

I have thus given you a rough sketch of the advantages this country promises for carrying on the manufacture of iron on a large scale; and so well am I convinced of their importance that I have determined on that account to remain some time in this country to aid in developing these resources. The details I have collected of most advantageous situations, I may at some future time communicate to one of the scientific Journals for publication, or make known to individuals able and willing to embark in the business. In such a cummunication an account of the various other veins and beds, such as the little veins of Galena (lead ore,) the

immense beds of sulphate barytes, etc., will find a more proper place than in the pages of a daily paper.

With respect, I am yours &c.

JAMES T. HODGE.

THE TRAFFIC ON RAILWAYS.—The Railway Magazine, published in England, gives the following calculation of the last weekly returns of forty railways, 1428 miles in length; Number of passengers on 25 railways, 329,039, consequently the total for the week must be about 500,000. The receipts for passengers on 39 railways, £88,588 12s. 6d.; ditto for goods on 34 railways, £20,411 3s. 8d.; total, £108,999 15s. 11d. This is an average of £76 1-4 per mile per week. The traffic therefore, is certainly at the rate of about four millions a year, and carrying fifteen millions of passengers.

Perhaps few of our readers know that in the neighboring town of Franklin, Ten., six steam looms are in active operation, and about *seventeen hundred yards of domestic shirting are turned out weekly.* This machinery also embraces carding and spinning gear, so that a bale of cotton put in at one end comes out quickly at the other converted into a bale of excellent cloth. We are informed by the enterprising proprietors, Messrs. Parks and Campbell, that the number of spindles now running in Tennessee is estimated at *sixteen thousand.—Rich. Banner.*

INTERESTING TO TOBACCO MANUFACTURES.—A bill is now before Parliament containing the following clause:—And be it enacted that no manufacturer of tobacco shall receive or take into, or have in his custody or possession any sugar, teracle, molasses or honey, (except for the necessary and ordinary use of his family, the proof whereof shall lie on such manufacturer,) nor shall any manufacturer of, or retailer of tobacco, receive or take into, or have in his custody or possession any commings or roots of malt or any ground or unground roasted grain, ground or unground chickory, lime, sand, umbre, ochre, or other earths, sea-weed, ground wood, peat or other moss, or any leaves or any herbs or plants (not being tobacco leaves or plants,) or any syrup, liquid substance, material, matter or thing to be used or capable of being used as a substitute for, or to increase the weight of tobbacco or snuff, on pain of forfeiting the same and two hundred pounds.

PHILADELPHIA, READING AND POTTSVILLE RAILROAD.—"We understand that the Engineer sent by the Emperor of Austria to examine the various Railroads of the United States, has fixed upon the Philadelphia and Reading Railroad as the best made road in the Union. The engineers of this road at the various stations are busily engaged in making drawings of the most important works on the road, for the use of the Austrian Government, some specimens which we have seen are highly credible to the gentlemen engaged, and will no doubt be duly appreciated by His Imperial Highness.